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**CLIMATE CHANGE**

The effects of worldwide warming in the Arctic, or climate change in the Arctic include rising temperatures, loss of sea ice, and melting of the Greenland ice sheet with a related cold temperature anomaly, observed in present years.[1][2][3] Potential methane release from the region, especially through the thawing of permafrost and methane clathrates, is also a concern. The Arctic warms twice as fast compared to the rest of the world.[4] The pronounced warming signal, the amplified response of the Arctic to global warming, it is often seen as a leading indicator of global warming. The melting of Greenland's ice sheet is linked to polar amplification.[5][6] According to a study published in 2016, about 0.5◦C of the warming in the Arctic has been attributed to reductions in sulfate aerosols in Europe since 1980According to the Intergovernmental Panel on enviromental Change, "warming in the Arctic, as indicated by daily maximum and minimum temperatures, has been as great as in any other part of the world."[8] The period of 1995–2005 was the warmest decade in the Arctic since at least the 17th century, with temperatures 2 °C (3.6 °F) above the 1951–1990 average.[9] Some regions within the Arctic have warmed even more rapidly, with Alaska and western Canada's temperature rising by 3 to 4 °C (5.40 to 7.20 °F).[10] This warming has been caused not only by the rise in greenhouse gas concentration, but also the deposition of soot on Arctic ice.[11] A 2013 article published in Geophysical Research Letters has shown that temperatures in the region haven't been as high as they currently are since at least 44,000 years ago and perhaps as long as 120,000 years ago. The authors conclude that "anthropogenic increases in greenhouse gases have led to unprecedented topical warmth.

**STATISTICS ON CAP MELTING**

From 2008 to 2011, Arctic sea ice minimum extent was higher than 2007, but it did not return to the levels of previous years.[32][33] In 2012 however, the 2007 record low was broken in late August with three weeks still left in the melt season.[34] It continued to fall, bottoming out on 16 September 2012 at 3.41 million square kilometers (1.32 million square miles), or 760,000 square kilometers (293,000 square miles) below the previous low set on 18 September 2007 and 50% below the 1979–2000 average.[35][36]

The rate of the decline in entire Arctic ice coverage is accelerating. From 1979–1996, the average per decade decline in entire ice coverage was a 2.2% decline in ice extent and a 3% decline in ice area. For the decade ending 2008, these values have risen to 10.1% and 10.7%, respectively. These are comparable to the September to September loss rates in year-round ice (i.e., perennial ice, which survives throughout the year), which averaged a retreat of 10.2% and 11.4% per decade, respectively, for the period 1979–2007Reliable measurement of sea ice edges began with the satellite era in the late 1970s. Before this time, sea ice area and extent were monitored less precisely by a combination of ships, buoys and aircraft.[25] The data show a long-term negative trend in recent years, attributed to global warming, although there is also a considerable amount of variation from year to year.[26] Some of this variation may be related to effects such as the Arctic oscillation, which may itself be related to global warming.[27]

The Arctic sea ice September minimum extent (i.e., area with at least 15% sea ice coverage) reached new record lows in 2002, 2005, 2007, and 2012.[28] The 2007 melt season let to a minimum 39% below the 1979–2000 average, and for the first time in human memory, the fabled Northwest Passage opened completely.[29] The dramatic 2007 melting surprised and concerned scientists

**POLAR CAP MELT**

This century, thawing of the various types of Arctic permafrost could release large amounts of carbon into the atmosphere. It has been estimated that about two-thirds of released carbon escapes to the atmosphere as carbon dioxide, originating primarily from ancient ice deposits along the ~7,000 kilometer long coastline of the East Siberian Arctic Shelf (ESAS) and shallow subsea permafrost. Following thaw, collapse and erosion of coastline and seafloor deposits may accelerate with Arctic amplification of climate warming.[51] Methane is released when the permafrost is melted by the ice-albedo positive feedback loop. The ice has melted so it can no longer reflect the suns heat, therefore the sea levels heat up melting the permafrost. Due to this the permafrost which has not been melted since the last ice is melted releasing methane into the atmosphere. Methane is twenty-seven times more powerful than Carbon Dioxide therefore it is more damaging towards the atmosphere. Methane takes seven years to wear away enough to become carbon dioxide which still stays in the atmosphere for several more years. <Peter Wadhams, 2016> Climate models suggest that during periods of rapid sea-ice loss, temperatures could increase as far as 1,450 km (900 mi) inland, accelerating the rate of terrestrial permafrost thaw, with consequential effects on carbon and methane release. Subsea permafrost occurs beneath the seabed and exists in the continental shelves of the polar regions.[54] This source of methane is different from methane clathrates, but contributes to the overall outcome and feedbacks.

Sea ice serves to stabilise methane deposits on and near the shoreline,[55] preventing the clathrate breaking down and venting into the water column and eventually reaching the atmosphere. From sonar measurements in recent years researchers quantified the density of bubbles emanating from the subsea

permafrost into the Ocean (a process called ebullition), and found that 100–630 mg methane per square meters is emitted daily along the East Siberian Shelf, into the water column. They also found that during storms, methane levels in the water column drop dramatically, when wind-driven air-sea gas exchange accelerates the ebullition process into the atmosphere. This observed pathway suggests that methane from seabed permafrost will progress rather slowly, instead of abrupt changes. CLASS SCHEDULE

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| **LESSON** | **TOPIC** | **ASSINGMENT** | **Points** | **DUE** |
| **1** | **What is Distance Learning?** | **Wiki #1** | **10** | **March 10** |
| **Presentation** | **20** |  |
| **2** | **History & Theories** | **Brief paper** | **20** | **March 24** |
| **Spring Break** | | | | |
| **3** | **Distance learners** | **Discussion 1** | **10** | **April 7** |
| **Group Project** | **50** | **April 14** |
| **4** | **Media selection** | **Bloog #1** | **10** | **April 21** |

**CHANGES IN FIONA**

Changes in vegetation are associated with the increases in landscape scale methane emissions.[58]



The growing season has lengthened in the far northern latitudes, bringing major changes to plant communities in tundra and boreal (also known as taiga) ecosystems.

For decades, NASA and NOAA satellites have continuously monitored vegetation from space. The Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Very High-Resolution Radiometer (AVHRR) instruments measure the intensity of visible and near-infrared light reflecting off of plant leaves. Scientists use the information to calculate the Normalized Difference Vegetation Index (NDVI), an indicator of photosynthetic activity or “greenness” of the landscape.

The maps above show the Arctic Vegetation Index Trend between July 1982 and December 2011 in the Arctic Circle. Shades of green depict areas where plant productivity and abundance increased; shades of brown show where photosynthetic activity declined. The maps show a ring of greening in the treeless tundra ecosystems of the circumpolar Arctic—the northernmost parts of Canada, Russia, and Scandinavia. Tall shrubs and trees started to grow in areas that were previously dominated by tundra grasses. The researchers concluded that plant growth had increased by 7 to 10 percent overall.

However, boreal forests, particularly those in North America, showed a different response to warming. Many boreal forests greened, but the trend was not as strong as it was for tundra of the circumpolar Arctic. In North America, some boreal forests actually experienced “browning” (less photosynthetic activity) over the study period. Droughts, forest fire activity, animal and insect behavior, industrial pollution, and a number of other factors may have contributed to the browning.

**HEAT DIFFERENTIATION AMONG ZONES**

"Satellite data identify areas in the boreal zone that are warmer and drier and other areas that are warmer and wetter," explained co-author Ramakrishna Nemani of NASA’s Ames Research Center. "Only the warmer and wetter areas support more growth."

"We found more plant growth in the boreal zone from 1982 to 1992 than from 1992 to 2011, because water limitations were encountered in the later two decades of our study," added co-author Sangram Ganguly of the Bay Area Environmental Research Institute and NASA Ames.[59]

The less severe winters in tundra areas allow shrubs such as alders and dwarf birch to replace moss and lichens. The impact on mosses and lichens is unclear as there exist very few studies at species level, also climate change is more likely to cause increased fluctuation and more frequent extreme events.[60] The feedback effect of shrubs on the tundra's permafrost is unclear. In the winter they trap more snow which insulates the permafrost from extreme cold spells, but in the summer they shade the ground from direct sunlight.[61] The warming is likely to cause changes in the plant communities.[62] Except for an increase in shurbs, warming may also cause a decline in cushion plants such as moss campion. Since cushion plants act as facilitator species across trophic level and fill important roles in severe environments this could cause cascading effects in the ecosystems.[63] Rising summer temperature melts on Canada's Baffin Island have revealed moss previously covered which has not seen daylight in 44,000 years.[64

# **Η ΟΙΚΟΓΕΝΕΙΑ ΜΟΥ**